UNION SWITCH & SIGNAL

645 Russell St.
Batesburg, SC 29006

Service Manual 5865

High Frequency Track Circuits

Installation and Maintenance

December, 1999

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1.1 GENERAL INFORMATION

The US&S High Frequency Track Circuit is designed to be used where short track circuits are required, such as in classification yards, to provide switch locking protection. Insulated joints are not necessary with this circuit.

The equipment is completely transistorized and is designed to operate from 117 volt, 60 Hz power source.

Since the track circuits are short, the condition of the ballast is not critical. More important is the ability to work in areas where there is rail film, such as normally found in classification yards. Tests with the high frequency circuits have shown no indication of failure to shunt when a heavy grease film mixed with dirt was applied to the rails.

Track circuits have been employed with lengths of between 60 and 250 feet, and no difficulty is foreseen in lengths up to 300 feet.

A typical high frequency track circuit consists of a transmitter, receiver and associated relay, connected between two (2) rail-to-rail shorts, which define the limits of the track circuit. The transmitter is connected approximately twenty (20) feet from one short with capacitors connected within the unit and on the output terminals to tune that section of the track to the transmitter frequency. The receiver is connected approximately twenty (20) feet from the other short with capacitors connected within the unit and on the input terminals to tune that section of the track to the transmitted frequency.

Electrically, this makes the enclosed section of track look like two tuned circuits coupled in parallel with the inductance of the untuned section of track in series. (See Figures 1-1 and 1-2.)

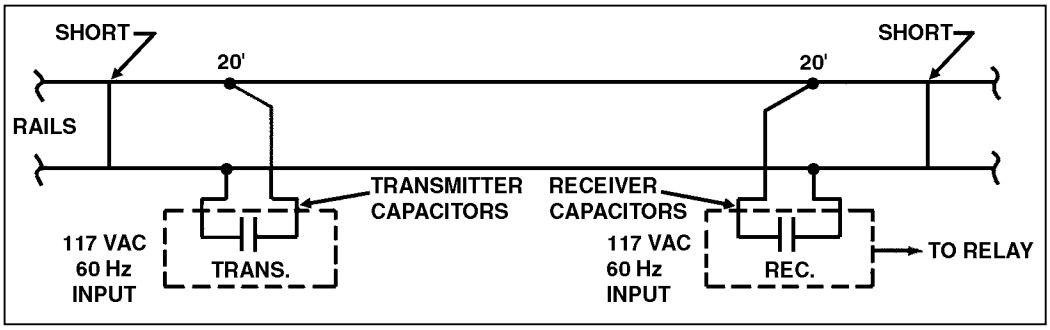

FIGURE 1-1. PHYSICAL LAYOUT

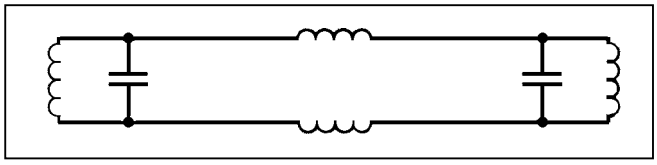

FIGURE 1-2. ELECTRICAL EQUIVALENT

The equipment is contained within a weatherproof case that is pedestal mounted on the wayside at 3 feet from the nearest rail. Power input, track, and relay output connections are made to an AAR terminal strip mounted internally. The receiver relay is external and can be located where convenient, up to several thousand feet away from the receiver.

1.2 R.A.I.L. TEAM AND TECHNICAL SUPPORT

The *Rapid Action Information Link (R.A.I.L.) Team* is comprised of a group of experienced product and application engineers ready to assist and resolve any technical issues concerning any US&S product.

Any questions regarding the contents of this Service Manual can be answered by contacting the R.A.I.L. Team toll free at 800-652-7276 or via e-mail: railteam@switch.com.

2.1 High Frequency Track Circuit Function

The High Frequency Track Circuit functions by applying bursts of high frequency energy into the tuned section of track from the transistor oscillator and power amplifier that form the transmitter. The energy is coupled through the rails into the tuned section of track at the receiver input. These bursts of energy are of approximately two-millisecond duration, with approximately eight-milliseconds between bursts. The input circuit of the receiver transformer couples this energy into a bridge rectifier, which converts the high frequency energy into square pulses of two-millisecond duration with eight-milliseconds between pulses. When these pulses are of sufficient amplitude to trigger the fail-safe peak detector, a separate frequency of approximately 220 kHz is generated in the receiver. This signal is amplified, detected and converted into a D-C control voltage to energize the relay. As long as the amplitude of the input triggers the peak detector, the relay will be held energized.

The relay will drop out from failure of input power to either the receiver or transmitter, from loss of connections to the rails or from normal shunting of the track by a car. This will de-tune and short either the output of the transmitter or input to the receiver, or both, depending on the position of the wheels within the limits of the track circuit.

Because of the rail-to-rail shorts, which define the limits of the track circuit, it is virtually impossible to get interference from adjacent circuits. Also, the receiver input is very selective with its high “Q” parallel resonant input circuit; and a transmitter of another frequency can be operated directly across the receiver inputs without causing false operation.

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3.1. Transmitter

The transmitter consists of:

- a printed circuit board containing a rectifier to convert the power supply to DC;
- an RF oscillator;
- a timing multivibrator, which controls the transmitter ON-OFF duty cycle;
- a single-ended Class “B” power amplifier;
- a power transformer, which converts the 117 volts, 60 Hz supply voltage to 32 volts; and
- a separate board with solder terminals for mounting capacitors to tune the track.

An AAR terminal strip provides for external connections to the track, the supply voltage and the case ground.

Provisions are included for mounting lightning arresters in installations where they are required. A complete unit can be furnished with or without arresters.

All of this is contained in a weatherproof box that is mounted near the rails, so that the track lead to the nearest rail is no longer than three feet. The supply voltage leads enter the box through the bottom, while the track leads enter through a weatherproof fitting on the end nearest the rails.

The transmitter output amplifier is capable of driving a minimum ballast impedance of 2 ohms/1000 ft. The timing and “Q” of the track will determine the load impedance seen by the transmitter with very little effect from the ballast since the track circuit is short. Typical load impedance of twelve ohms would permit peak output power during the pulse of approximately fifty watts. The efficiency of the circuit is very high due to Class “B” operation and low duty cycle.

The available frequencies for operation are 46.5 kHz, 57 kHz, 71. 5 kHz, and 89 kHz.

3.2 Receiver

The receiver consists of:

- a printed circuit board containing all the circuitry necessary to convert the R.F. signal received from the track to a DC voltage (to operate a 400 ohm relay);
- a power transformer (to change the 117 volts, 60 Hz supply voltage to 25. 2 volts, 60 Hz); and
- a separate board with solder terminals for mounting capacitors to tune the track.

An AAR terminal strip provides for external connections to the track, supply voltage and relay. Provisions are included for mounting lightning arresters in installations where they are needed. All of this is contained in a weatherproof box, which is mounted near the rails so that the track lead to the nearest rail is no longer than three (3) feet. The supply voltage and relay leads will enter the box through the bottom, while the track leads will be brought through a weatherproof fitting on the end towards the rails.

3.3 ASSOCIATED HARDWARE

3.3.1 Track Connections and Rail Bonds

The track connections, rail bonds, and rail-to-rail shorts must be very securely fastened and properly located or the track circuit cannot function properly. Any loosening, breaking or shifting of connections can change the tuning or completely disable the system.

All track leads should be AWG #6, insulated, stranded wire, or equivalent insulated bond wire.

These leads should be twisted at least three twists per foot between the nearest rail and the transmitter or receiver mounting box. The lead to the far rail must be as short as possible.

The rail-to-rail shorts consist of two leads of the same wire as the track leads and spaced a minimum of five inches apart with staples driven into the ties. The ends must be securely bolted or welded to the web of the rails.

All rail bonds must be heavy gauge, railhead-type, either welded or swaged securely into the rail for best operation. Longer bonds may be used where rail hardware makes it necessary, but the railhead-type is preferred and should be used whenever possible.

In applications where two track circuits are in series and a sharp transfer from one circuit to the other is required, a diagonal shunt must be installed in a ten-foot section of track. This diagonal must be made of three leads equivalent to the track leads. These may be connected at one point on each rail, but the leads must be spaced a minimum of five inches apart and stapled to the ties between the rails. The receiver of one circuit is connected at one end of the diagonal shunt, and the receiver or transmitter of the other circuit is connected at the other end of the diagonal shunt (See Figure 3-1) for further information, refer to *Section 4.0 Application and Installation Data*.

3.3.2 Receiver Relay

The receiver is designed to operate a relay with a 400-ohm coil, typically the PN-150B (N322500-001) or PN-50B (N292701). The pick-up voltage is normally 5.3 volts DC and the drop-away 1.9 volts DC. The current at 5.3 volts is only .0132 ampere; therefore, the relay can be located several thousand feet from the receiver and still be operational.

3.3.3 Lightning Protection

Provision has been included for mounting a Style USG Arrester, N314265, from each track lead to ground in both the receiver and transmitter. Actual installation of the arresters is required when the particular track circuit is isolated from others or when it is the first or last of a number of track circuits along a section of track.

These arresters permit a maximum of 300 volts before breakdown. The pedestal that the equipment is mounted on provides grounding for the arresters. However, in areas where poor ground conductivity is experienced, conventional ground rods may be used with the arresters connected to the pedestal, the ground rod or both.

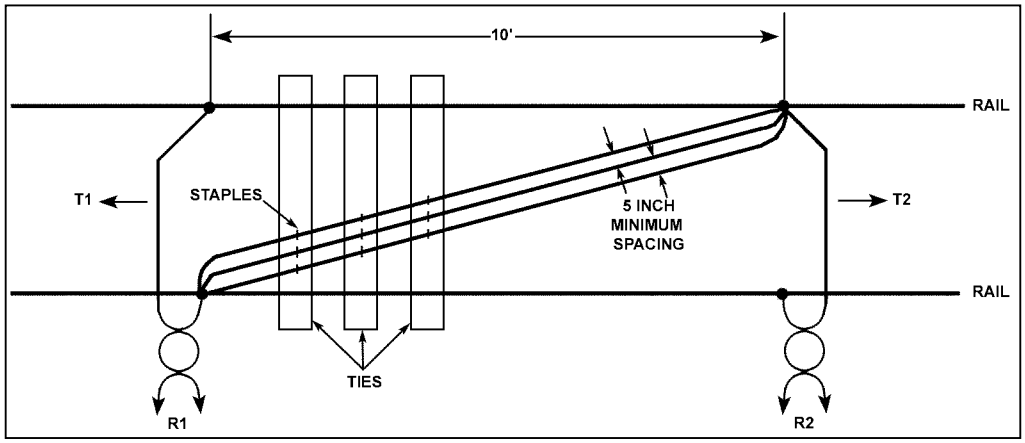

FIGURE 3-1. DIAGONAL SHUNT INSTALLATION

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4.1. FREQUENCY SELECTION

There are four frequencies available, 46.5, 57, 71.5 and 89 kHz. To assure that two track circuits operating on the same frequency do not interfere with each other, the following rules shall be observed.

1. Do not install track circuits directly parallel to each other on adjacent tracks unless the operating frequencies are different. Where there are three or more tracks in parallel, every other track may have the same frequency.

2. Do not install track circuits of the same frequency along the same track, unless a track circuit of a different frequency separates them.

3. Where two track circuits are to be installed with a diagonal rail-to-rail short between them to provide overlap of the two circuits, only the lowest and highest frequency available are to be used. This is presently 46.5 kHz for the lowest and 89 kHz for the highest.

4. In long track circuits, apply the lowest frequency available.

4.2 TRACK CIRCUIT CONNECTION ARRANGEMENTS

4.2.1 General Information

The frequency allotted for each circuit shall be determined from the rules given in *Section 4-1 Frequency Selection*.

Railhead bonds shall be used on all rail joints; and all other joints shall be bonded as short as possible, depending on track hardware conditions.

4.2.2 Typical Track Circuit Illustrations

The following illustrated track circuit arrangements, shown in Figures 4-1 through 4-6 are given as examples that should provide sufficient information for proper installation of these track connections, as well as any not specifically given.

The letters shown in parenthesis on each illustration indicate the applicable note from the following list.

(a) Rail-to-rail short. Consists of two AWG #6 stranded copper insulated wire or equivalent, separated a minimum of five inches. The wire is stapled to the tie and securely attached to the web of the rail, either at a common point connection or at two separate points, while maintaining the five-inch separation.

(b) Track leads. The leads to the transmitter and receiver must be twisted three twists per foot from the nearest rail to the unit housing, and the distance to the nearest rail must be three feet or less.

(c) Where presence detectors are used, the detector “loop” must be located between the transmitter and receiver rail connections as shown. Under no circumstances may part of the “loop” be within a tuned section.

(d) The diagonal shunt (see Figure 3-1).

(e) Switch bonding. Bonding is necessary around heel blocks and between rails behind the heel block.

(f) Switch rail-to-rail shorts. The rail-to-rail shorts must be between the “frog” and rail connections of transmitter or receiver.

(g) Switch track leads. The rail connections for transmitter or receiver shall be made to the fixed rail.

(h) Shunt zone. Maximum variation of shunting point will fall between the limits shown.

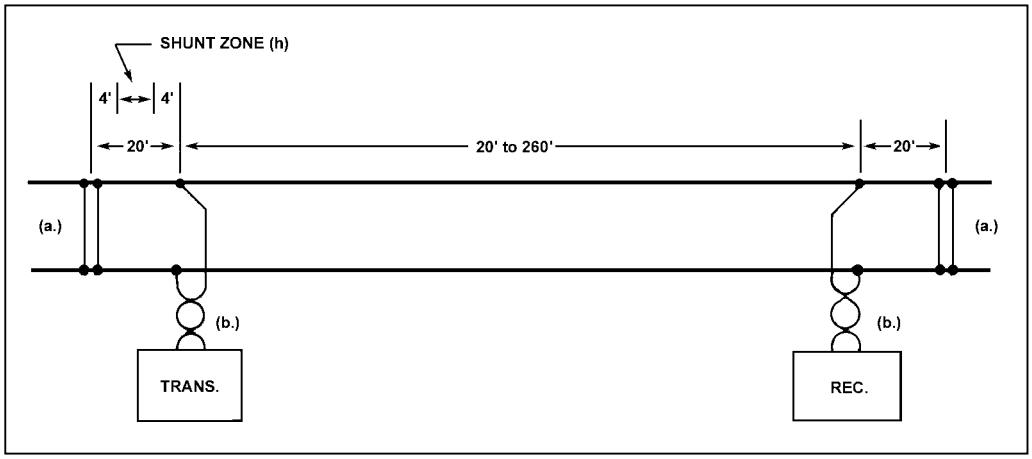

FIGURE 4-1. SINGLE TRACK CIRCUIT

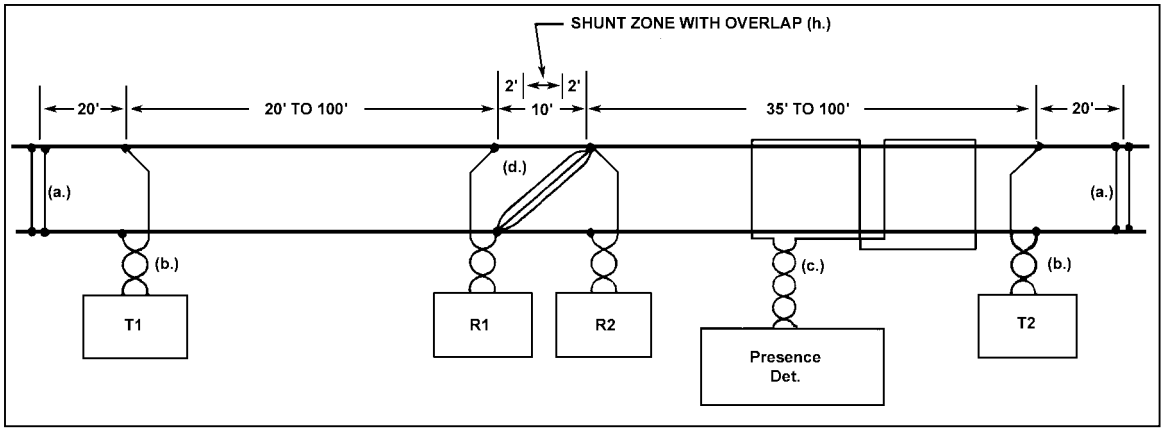

FIGURE 4-2. DUAL CIRCUIT WITH DIAGONAL SHUNT

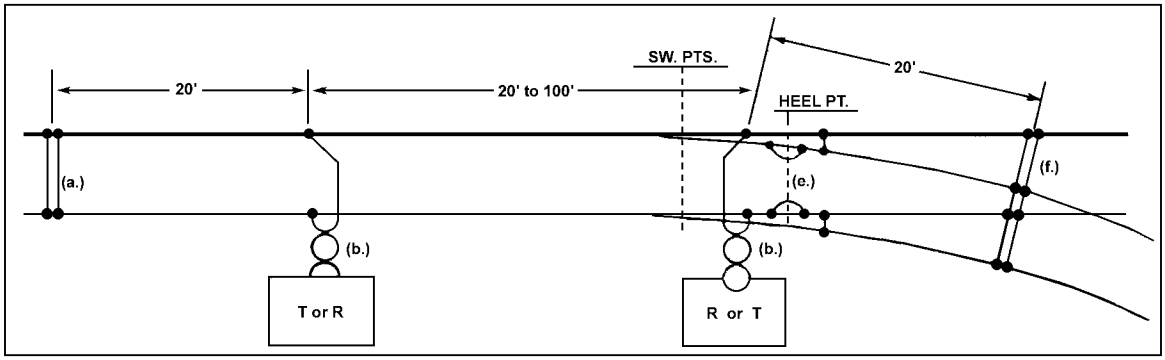

FIGURE 4-3. SINGLE SWITCH TRACK CIRCUIT

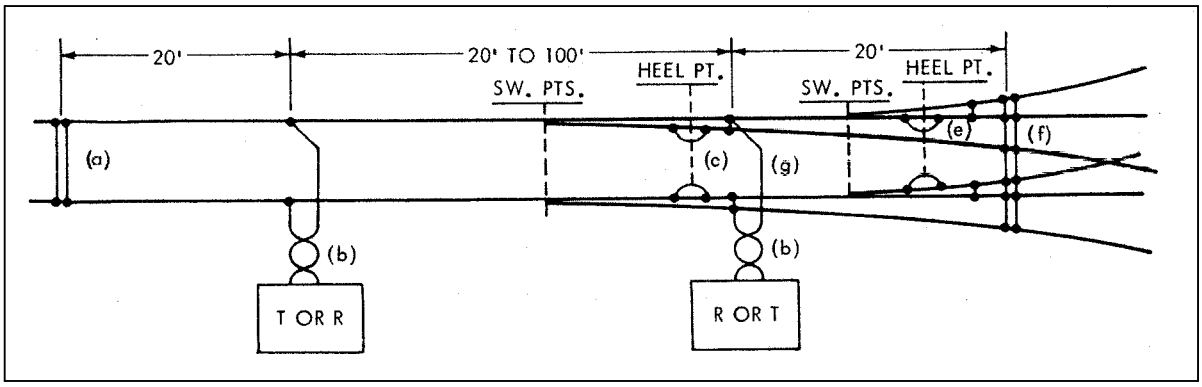

FIGURE 4-4. LAP SWITCH TRACK CIRCUIT

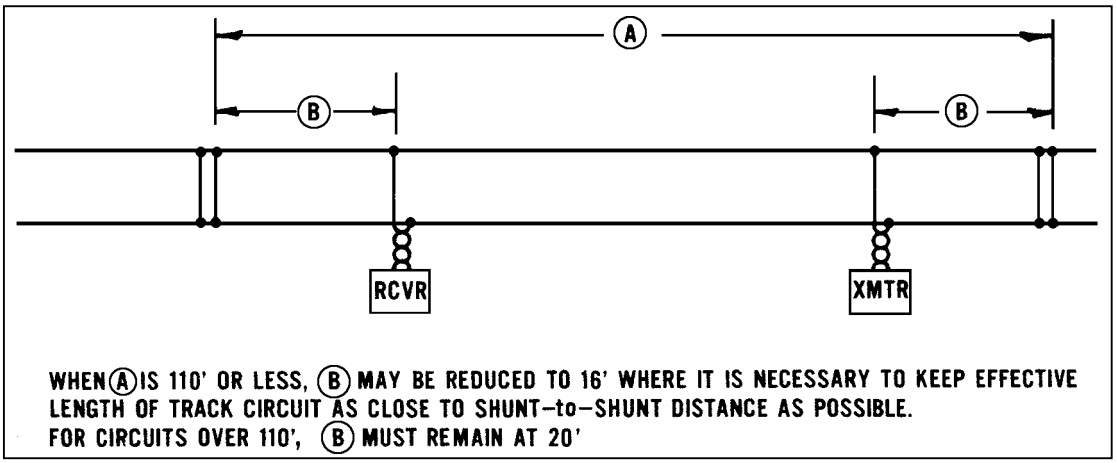
A
B
B
RCVR
XMTR
WHEN (A) IS 110' OR LESS, (B) MAY BE REDUCED TO 16' WHERE IT IS NECESSARY TO KEEP EFFECTIVE LENGTH OF TRACK CIRCUIT AS CLOSE TO SHUNT-to-SHUNT DISTANCE AS POSSIBLE.
FOR CIRCUITS OVER 110', (B) MUST REMAIN AT 20'

FIGURE 4-5A. SHORT CIRCUITS

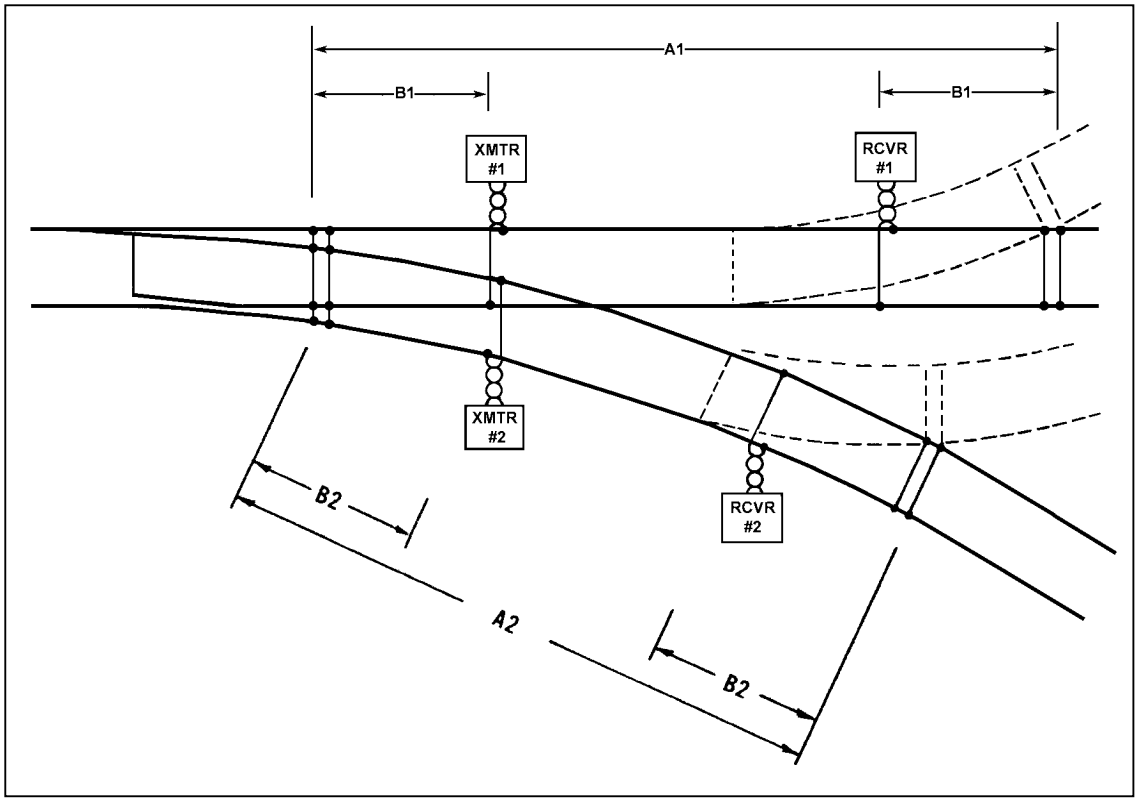

FIGURE 4-5B. SHORT CIRCUITS

Where space requirements necessitate, such as close-coupled switches (shown dotted), two circuits may be “overlapped” as shown. Each circuit will shunt independently. A1 need not equal A2, although all dimensions are subject to the length limitations as shown in Figure 4-5A. The transmitters can be staggered, if required, as shown in Figure 4-5B.

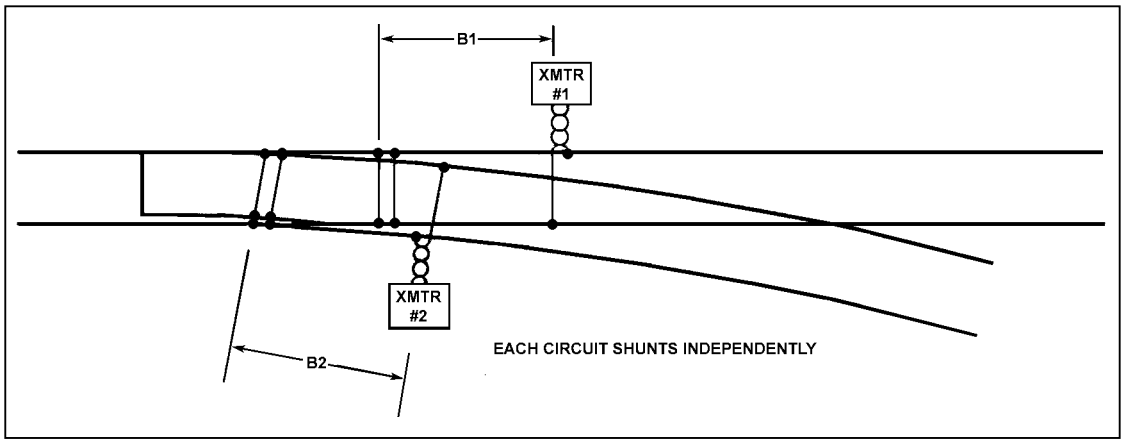

FIGURE 4-6. OVERLAPPED CIRCUITS

4.3 EQUIPMENT MOUNTING DATA

A transmitter or receiver basic housing consists of a cast iron box, M374986, with cover M347723, and a pedestal, M224650, which are shipped separately. The unit is mounted near the rails with the pedestal buried in the ground, so that the bottom of the box is two to four inches above the ground. The length of the track lead to the nearest rail shall be no longer than three feet (see Figure 4-7).

The 117 volt, 60 Hz power lead and the relay control wires are brought through a special opening in the pedestal and through the bottom of the box. The track leads are brought through the end of the box nearest the rails. The terminals on the AAR terminal strip are identified for convenience in wiring all external connections. A second solder-type terminal strip is provided to mount the tuning capacitors required to resonate that section of track between the track lead connections and the rail-to-rail short.

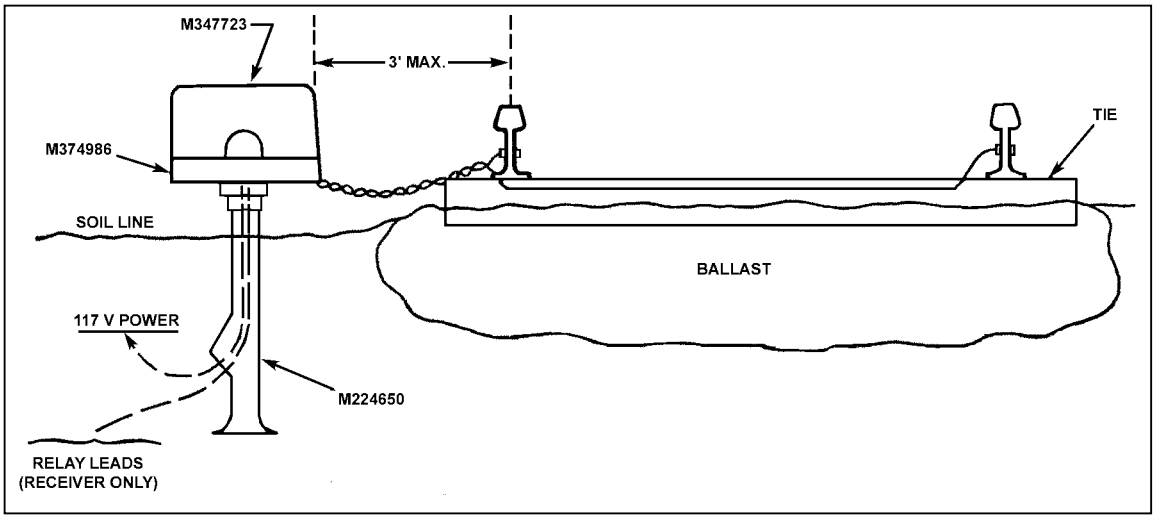

FIGURE 4-7. MOUNTING EQUIPMENT

4.4 TUNING AND SENSITIVITY ADJUSTMENTS

Proper tuning of the track is most easily accomplished by using an oscilloscope and a decade capacitor box. A fixed capacitor has been installed on the track lead terminal strip. Additional capacitors must be installed during installation to fine-tune the track. These capacitors will be in parallel with the fixed capacitor. Before any AC power is connected to the transmitter, connect a decade capacity box to the track lead and set it to 1 MFD to tune the track. Then turn on the power and reduce the decade box setting until a maximum signal is obtained across the terminal as discussed below. After tuning, fixed capacitors equal to the final setting of the decade box are then installed.

The range of capacitance required to tune a track circuit will vary from approximately .33 MFD for the highest frequency to approximately 2.0 MFD for the lowest frequency, depending on the installation arrangement.

In most cases, the track circuit will be short enough that it will be best to tune the transmitter and receiver simultaneously, or at least back and forth, until the maximum signal is obtained.

To tune the transmitter, it is best to connect an oscilloscope at the rail connections and the decade box at the track connections inside the transmitter enclosure.

To tune the receiver, it is best to connect both the oscilloscope and decade box at the track connections inside the receiver enclosure. Temporarily connect a non-inductive 10-ohm, 50-watt resistor in series with one lead of the transmitter.

Adjust the decade capacitor boxes in equal steps at both the transmitter and receiver until resonance is obtained in both circuits. This is indicated by obtaining a maximum signal on the scope.

Note

The capacitance at the receiver and transmitter may differ 10 to 20 percent at resonance in a straight track circuit, and nearly 100 percent when one is on straight track and the other at a diagonal shunt. Remove the resistor and recheck the tuning before proceeding.

The amplitude of the signal at the transmitter may be between 50 and 80 volts peak-to-peak, while at the receiver it may be between 50 and 150 volts peak-to-peak.

When the capacitance value has been determined, remove the decade box, and solder fixed capacitors to the terminal board provided in each enclosure, equal to the decade setting. In every case, choose capacitors that are equal to or slightly less than the decade setting, never larger.

The following standard values should provide enough combinations to satisfactorily tune all circuits.

TABLE 4-1 STANDARD VALUES FOR TUNING CIRCUITS

.015 MFD	±10%	200 volt	J709144-0076
.047 MFD	±10%	200 volt	J709144-0075
.10 MFD	±10%	200 volt	J709144-0083
.15 MFD	±10%	200 volt	J709144-0082
.33 MFD	±10%	200 volt	J709144-0081
.47 MFD	±10%	200 volt	J709144-0080
.56 MFD	±10%	200 volt	J709144-0079
.68 MFD	±10%	200 volt	J709144-0078
1.0 MFD	±10%	200 volt	J709144-0077

NOTES

1. On track circuits longer than 100', tuning should be done by first shorting the receiver track terminals and then adjusting the transmitter decade box for maximum signal. Finally remove the short from the receiver and tune the receiver end.
2. For diagonal shunt arrangements with two circuits adjacent to each other, tune the low frequency unit first with the high frequency circuit open circuited, with the low frequency circuit intact and tuned.

After the tuning capacitors have been installed, proceed with the sensitivity adjustment as follows:

(a) Connect an oscilloscope across the receiver input terminal.

(b) Connect a DC voltmeter (set on the 10-volt range) across the relay terminals. (A 400-ohm relay or resistor should be connected to the terminals for proper loading.)

(c) Connect a rail-to-rail shunt on the rail midway between the receiver track connections and the receiver rail-to-rail short. The rail-to-rail shunt wire should be at least #6 AWG and not longer than seven feet. See Figure 4.8.

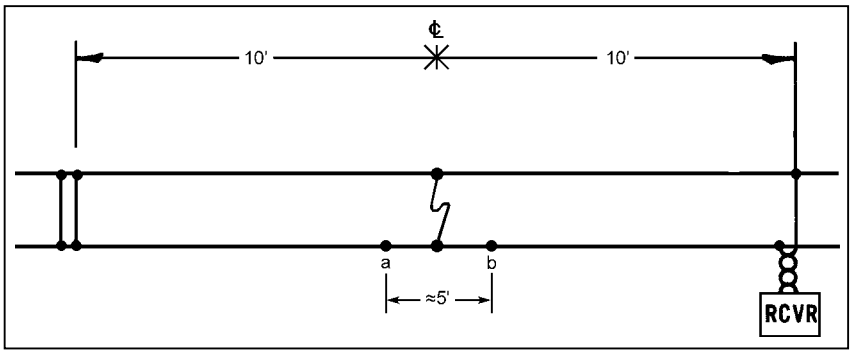

FIGURE 4.8 RAIL-TO-RAIL SHUNT CONNECTION

Note:

The location of the shunt in the center of the shunt zone as shown in Figure 4.8 will satisfy most applications. However, in congested areas where there is an abundance of steel traversing between the rails in the shunt zone, a shift of four or five feet of the shunt location closer to the receiver might be necessary to properly adjust the track circuit.

(d) Set the sensitivity control on the receiver for a reading of 1.9 ± .1 volt DC on the multimeter.

(e) Loosen the south end of the rail-to-rail shunt and connect to point “a.” Verify that the voltage level increases.

(f) Move the south end of the rail-to-rail shunt from point “a” to point “b.” Verify that the voltage level decreases.

(g) Remove the shunt. The voltage should rise to 5.8 ± .3 volts DC.

The circuit is now ready for operation.

Regularly scheduled maintenance for any type of equipment is the best way to assure reliable operation for a long period of time. Therefore, the following information is given to assist in establishing some form of periodic inspection and test.

5.1 TEST EQUIPMENT AND PERIODIC INSPECTION

For a quick simple check of the equipment's general condition, all that is needed is an analyzer similar to a Simpson Model 260. The periodic test should consist of the following checks:

5.1.1 Transmitter

Visibly inspect for moisture damage and component discoloration from overheating. Refer to Figure A-3 for transmitter circuit and parts reference.

Note the following voltages:

(a) Line voltage, 117 volts ± 10%, 60 Hz.

(b) Power input to board, 32 volts ± 10% 60 Hz.

(c) DC across C8, 40 volts ± 10%

(d) DC across C1, 26 volts ± 10%

*(e) Output, 2.5 volts RMS minimum

* This low voltage reading is the result of a 20% duty cycle, pulse operation. Continuous operation of the transmitter output would give a reading approximately five times as high.

5.1.2 RECEIVER

Visibly inspect for moisture damage and component discoloration from overheating. Refer to Figure A-4 for receiver circuit and parts reference.

(a) Line voltage, 117 volts ± 10%, 60 Hz.

(b) Power input to board, 25.2 volts ± 10% 60 Hz.

(c) DC across C16, 36 volts ± 10%.

(d) Relay voltage, 5.8 volts DC, ± .3 volts.

*(e) Input from track, 2.5 volts minimum.

* This is the RMS reading of the 20% duty cycle of the transmitted pulse. If the reading is between 12 and 20 volts RMS, the transmitter is in continuous transmission instead of pulse.

The historical record of several inspections provides a means of determining when a unit is about to fail, because a consistently repeated reading establishes the proper operating reference. Therefore, when a particular reading begins to change from one inspection to another, this can be interpreted as an approaching failure in that unit.

5.2 FIELD SERVICING

In the event that actual failure occurs, the voltage checks of the periodic inspection will provide enough information to determine where the failure has occurred. Interpretation of readings is shown on the following troubleshooting tables.

TABLE 5-1. TRANSMITTER FIELD SERVICING

	INDICATION	CORRECTIVE ACTION
1.	No line voltage	Check power distribution system and cabling.
2.	Low line voltage when circuit is connected.	Check transformer for shorted turns, or shorts on the printed circuit board. Replace transformer or printed circuit board.
3.	Low DC voltages.	(a) Check tracks and track leads for shorts. (b) Check to see that tuning capacitors are not broken loose or defective. (Detuned circuit loads DC supply) (c) Replace printed circuit board if (a) and (b) are good.
4.	Low output.	Same as step three (3).
5.	High output.	Replace printed circuit board as timing multivibrator circuit is defective, allowing transmitter to operate continuously.

TABLE 5-2. RECEIVER FIELD SERVICING

	INDICATION	CORRECTIVE ACTION
1.	No line voltage	Check power distribution system and cabling.
2.	Low line voltage when circuit is connected.	Check transformer for shorted turns or shorts on the printed circuit board. Replace defective part.
3.	Low DC voltage	If line voltage is good, check for a short circuit in output to relay or low relay voltage. Replace board.
4.	No relay voltage	Check for signal on input terminals. If input from track is low or too high, trouble is in track or transmitter. **NOTE** If input RMS voltage is greater than 12 V RMS, the transmitter is operating continuously and the receiver cannot respond to a continuous input.
5.	No input	Check all track leads and rail connections for opens or shorts. Check transmitter output. Repair track leads or replace transmitter as required.

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The parts list that follows is a tabulation of the parts that may be necessary to maintain this equipment. These parts may be ordered directly from Union Switch & Signal Inc.

A.1 Transmitter and Receiver Assemblies

Description			Part No. Complete	Part No. less Pedestal
Transmitter Assembly, with Arrestor				
46.5	kHz	Transmitter	* X451147-0135	N451147-0103
57	kHz	Transmitter	* X451147-0139	N451147-0107
71.5	kHz	Transmitter	* X451147-0143	N451147-0111
89	kHz	Transmitter	* X451147-0147	N451147-0115
Receiver Assembly, with Arrestor				
46.5	kHz	Receiver	* X451147-0133	N451147-0101
57	kHz	Receiver	* X451147-0137	N451147-0105
71.5	kHz	Receiver	* X451147-0141	N451147-0109
89	kHz	Receiver	* X451147-0145	N451147-0113

A.2 Circuit Boards

Circuit Boards for Transmitters				
46.5	kHz	Transmitter		N451055-1201
57	kHz	Transmitter		N451055-1202
71.5	kHz	Transmitter		N451055-1203
89	kHz	Transmitter		N451055-1204
Circuit Boards for Receivers				
46.5	kHz	Receiver		N451055-1301
57	kHz	Receiver		N451055-1302
71.5	kHz	Receiver		N451055-1303
89	kHz	Receiver		N451055-1304

* Complete Assemblies include Pedestal

A.3 General Parts List

Item #	Description	Part No.
5	Box	M374986
10	Cover	M347723
15	Elbow, 1st St M I Galv	J32485
20	Gsk Nprn Spg ½ x ½	A690937
25	Not used	Not used
30	SC 3/8 x 1-¼ Set Cad P	J50577
35	Nut, 3/8 Hex Stl Cad P	J48009
40	Plate, Mounting	M451148-0101
45	SC ¼ - 20 x 7/8 Fil Stp	J52202
50	Washer, ¼ M LK S TP	J47775
55	Block, Terminal, 7 way	M225586
60	Block, Terminal 3 way	M109154
65	Washer	J47818
70	Nut	M29103
75	Nut	M29101
80	Arrester	N451552-0101
85	Connector, Term	M47290
90	Chassis	See Aux Tab
95	Transformer	See Aux Tab
100	Board, Pri-Cir	See Aux Tab
105	Board, Term	J776611
110	Spacer	J772336
115	Nut-6-31 Hex Stl Tr	J048148
120	Bushing 2 ½ x 2 Red	J032088
125	Bushing, 2 x 1 ¼ Red	J32054
130	Nut, Lock	M373656
135	Plastic Cap Plug	J703517
140	Plastic Cap Plug	J703516
145	Elbow, 1 ¼ St M I Galv	J32486
150	Pipe, 1 ¼ Galv	M437182
155	Nut, ¼ - 20 Hex Stl Tp	J48002
160	SC 4-40x 5/16 bind Stl Tp	J50996
165	Washer 4 M Lk S Tp	J47765
170	Washer, 4 Plate S Tp	J47640
175	SC 8-32 x ½ Bind Stl Tp	J50992
180	Washer 8 M Lk S Tp	J47681
185	Washer 8 plate S Tp	J47745
190	Spacer	M485696
195	SC 8-23 x 3/8 Bind Stl Tp	J507235
200	SC 2 x ¼ Rd Type U Drive Sc Tp	J52648
205	Nut 8-32 Hex Stl Tp	J48166

Item #	Description	Part No.
210	Plate, Name	M451425-9701
215	Receptacle, DX	J72030
220	SC 6-32 x 3/8 Pan Stp	J507262
225	Pipe, 1” Galv	M26503
230	Screen	M435695
235	Bushing, 1” Conduit	J69677
240	Bolt, ½ - 13 x 3-1/2 Hex	J046563
245	Nut, ½ Hex X Jam Cad P	J48016
250	Nut, ½ Hex Stl Cap P.	J48013
255	Washer ½ Plat Stl Cad P	J47503
260	Washer # 6 Lock Stl	J047662
265	Tag, B x 110	J75510-0689
270	Tag, N x 110	J75510-0080
275	Rag, Relay +	J75510-1157
280	Tag, Relay -	J75510-1158
285	Tag, Track 1	J75510-1169
290	Tag, Gnd	J75510-0566
300	Term, #6 Amp	J730239
305	Term. #12 – ¼ amp	J730041
310	Wire #18 Flex (Bk)	A45665-0000
315	Wire, #18, Flex (W)	A45665-0009
320	Grommet	J751238
325	Scr. ¼ - 20 x 358 Pnh Stl	J507263
330	Nut, Insulated	J48300
335	SC 4-40 x ¼ Flat Stl Tp	J521070
340	Tag, Track E	J75510-1170
345	Term # 10 Amr	J730048
350	Initial Tuning Cap	See Tab
355	Wire, #20 Bare Copper	A043180
360	Wire, #20, PVC Grn M-258-30	A045505-0004
365	Tubing	A774201
370	Wshr – 10 Flt Stl	J475077

A.4 Auxiliary Tabulation

RCVR or XMTR Housing	Chassis Suffix	Group	Freq kHz	Circuit Bd		Transformer		Initial Tuning Capacitor	Mfd
N451147				F451055	SH	C8605	SH		
-0101	-0117	1	46.5	N451055-1301	13	J730805	--	J709144-0178	0.68
-0103	-0119	3	46.5	N451055-1201	12	N435551	68	J709144-0078	0.68
-0105	-0121	1	57	N451055-1302	13	J730805	--	J709144-0078	0.60
-0107	-0123	3	57	N451055-1202	12	N435551	68	J709144-0078	0.68
-0109	-0188	1	71.5	N451055-1303	13	J730805	--	J709144-0081	0.33
-0111	-0127	3	71.5	N451055-1203	12	N435551	68	J709144-0081	0.33
-0113	-0189	1	89	N451055-1304	13	J730805	--	J709144-0082	0.15
-0015	-0131	3	89	N451055-1204	12	N435551	68	J709144-0082	0.15

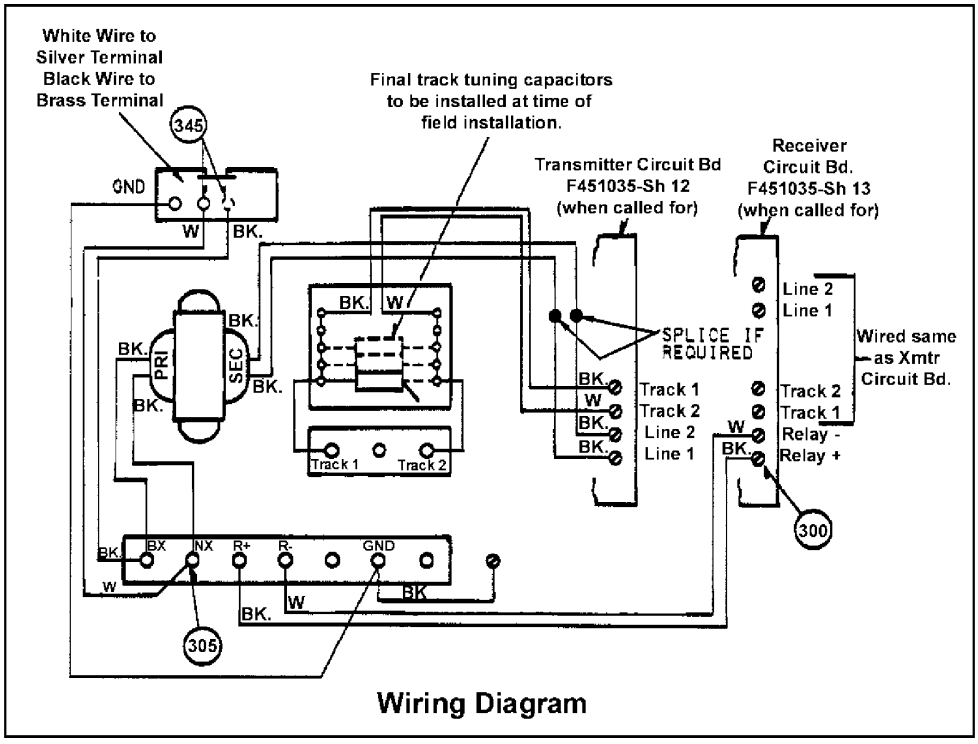


FIGURE A-1. WIRING DIAGRAM FOR HIGH FREQUENCY TRACK CIRCUITS

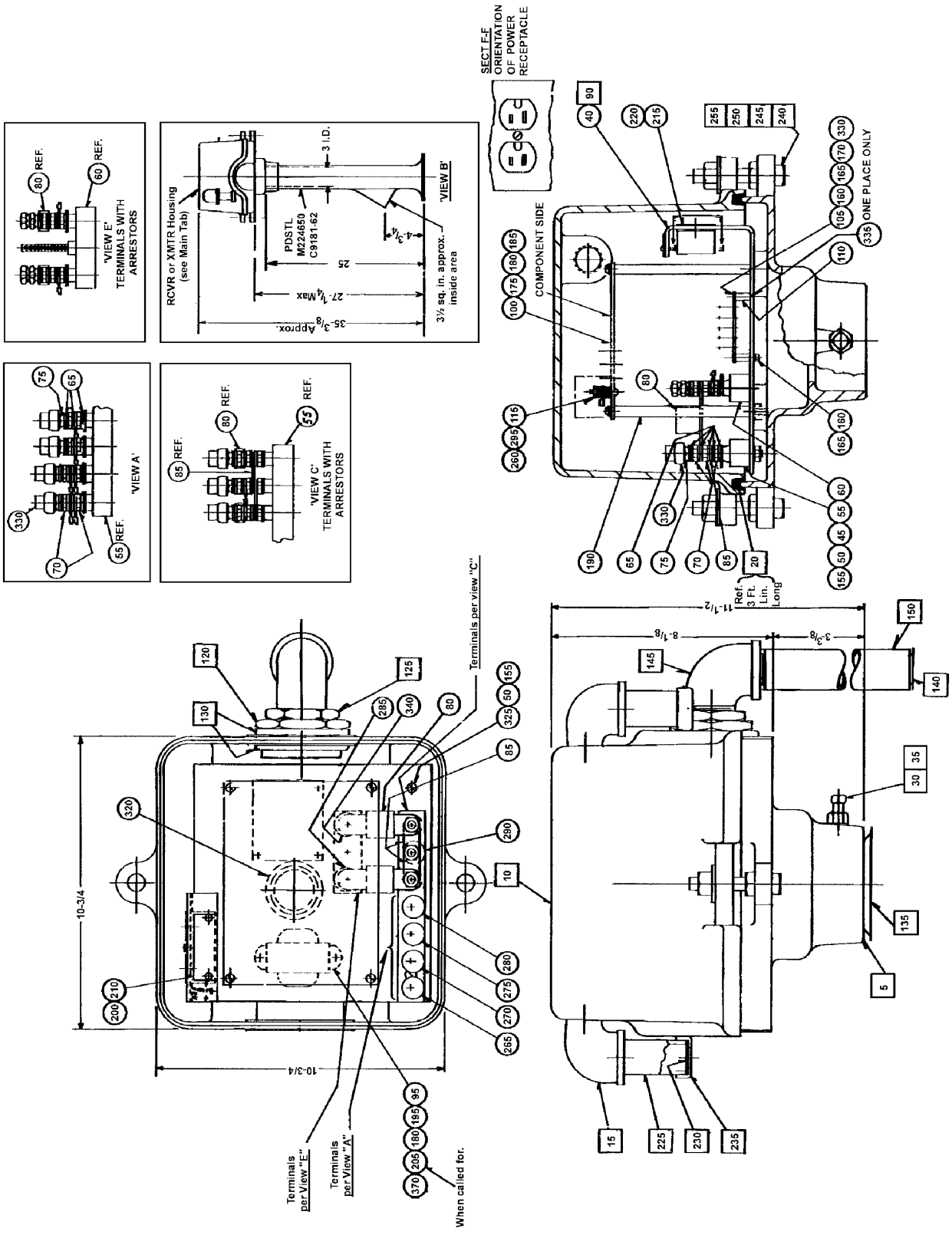
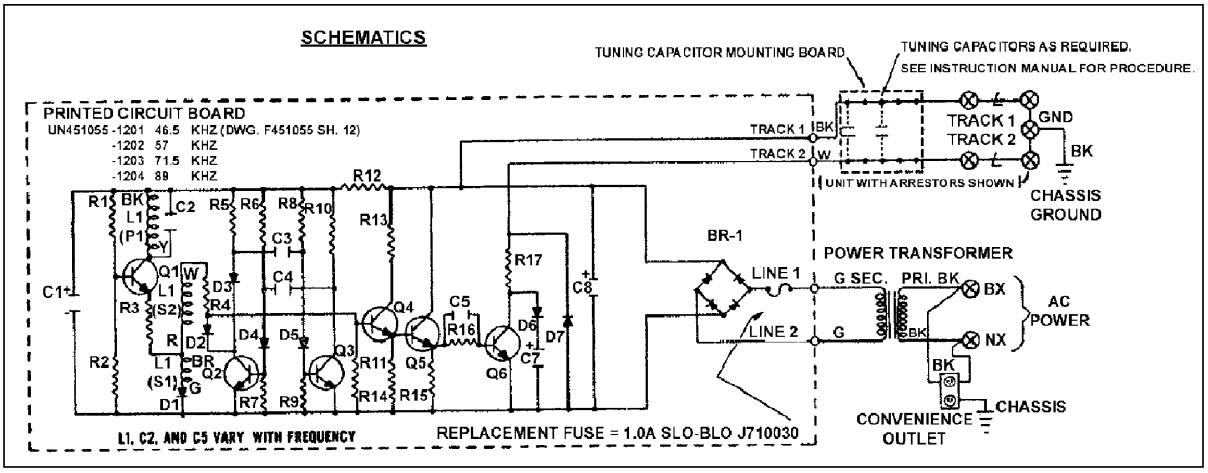
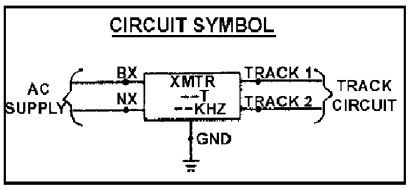


FIGURE A-2. ASSEMBLY OF EQUIPMENT FOR HIGH FREQUENCY TRACK CIRCUITS





TERMINALS ON SCHEMATIC

- SOLDER LUG FOR FIELD INSTALLED TUNING CAPACITORS
- SCREW TERMINAL ON EDGE OF PRINTED CIRCUIT BOARD
- ⊗ - AAR TERMINAL FOR EXTERNAL WIRING

ORDERING REFERENCES

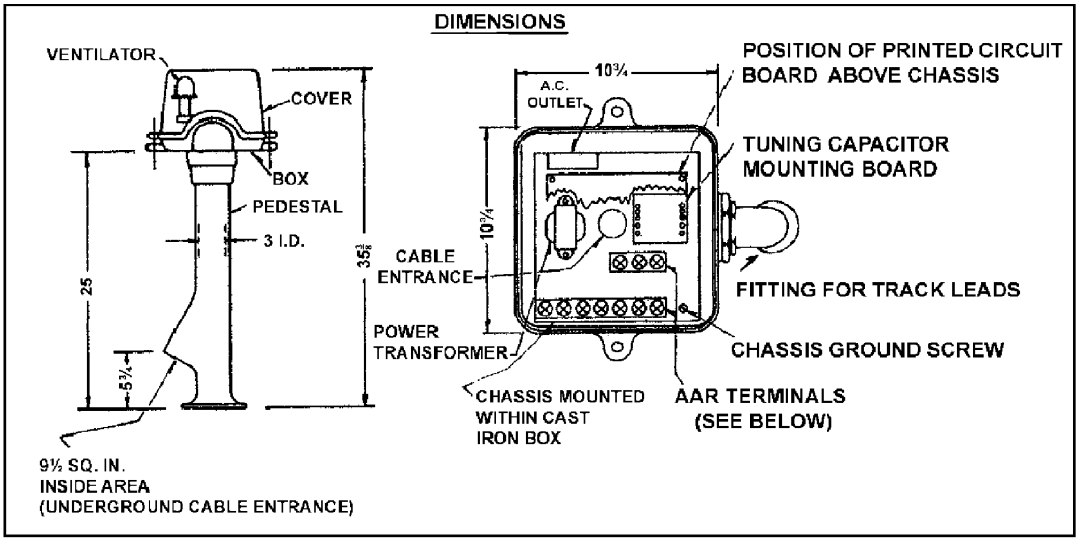
PART NUMBER (DWG. F451147 SH. 01)	FREQUENCY KHZ
N451147-0103	46.5
N451147-0107	57
N451147-0111	71.5
N451147-0115	89

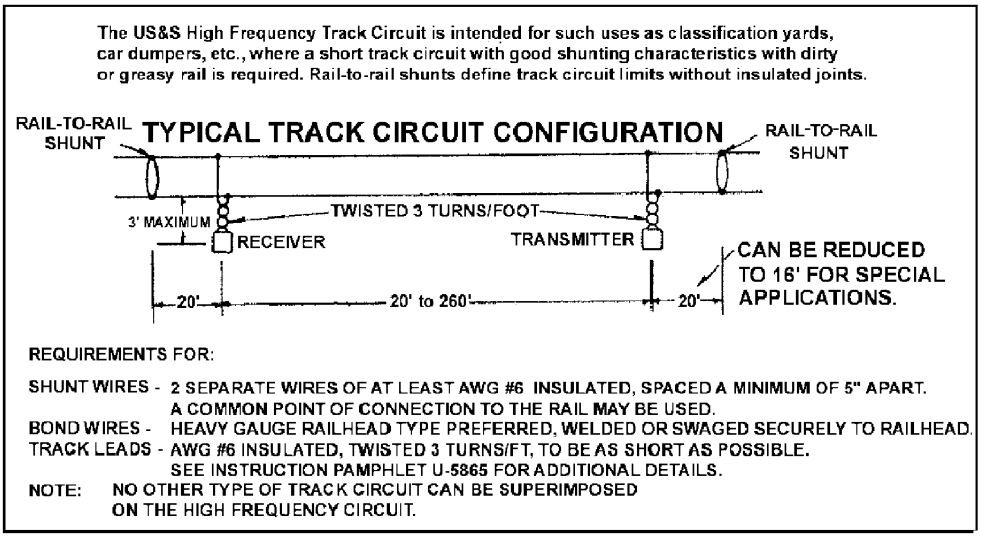
ALL PART NUMBERS DISPLAYED INCLUDE LIGHTNING ARRESTERS

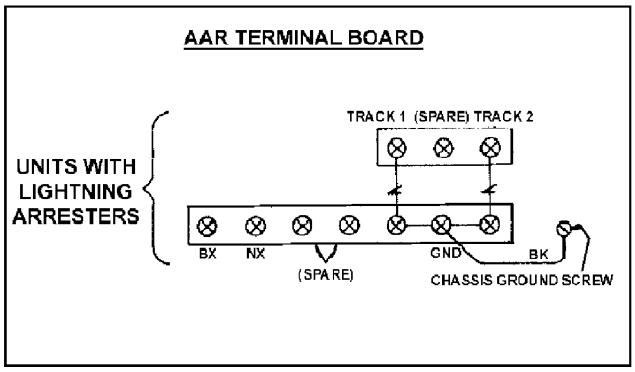
LEGEND	TYPE/VALUE
C1	47 MF.
C3	.15 MF
C4	.068 MF.
C7	100 MF
C8	1000 MF.
D1 to D7	IN4003
Q1, 4	2N2270
Q2, 3	2N3643
Q5	2N3715
Q6	2N3716
R1	4.7K
R2	2.0K
R3	620
R4, 14	1.0K
R5	2.4K
R6	47K
R7, 9	10K
R8	82K
R10	3.9K
R11	6.8K
R12	430, 2W
R13, 15	100, 1W
*R16	82
R17	.3, 7W

*Obsolete Motorola Transistor replaced with Solid State Transistor with higher gain, thus, requiring R16 Resistor value change.

FIGURE A-3A. TRANSMITTER CIRCUIT DIAGRAM AND PARTS REFERENCE




The US&S High Frequency Track Circuit is intended for such uses as classification yards, car dumpers, etc., where a short track circuit with good shunting characteristics with dirty or greasy rail is required. Rail-to-rail shunts define track circuit limits without insulated joints.
TYPICAL TRACK CIRCUIT CONFIGURATION
RAIL-TO-RAIL SHUNT
RAIL-TO-RAIL SHUNT
3' MAXIMUM
TWISTED 3 TURNS/FOOT
RECEIVER
TRANSMITTER
CAN BE REDUCED TO 16' FOR SPECIAL APPLICATIONS.
20'
20' to 260'
20'
REQUIREMENTS FOR:
SHUNT WIRES - 2 SEPARATE WIRES OF AT LEAST AWG #6 INSULATED, SPACED A MINIMUM OF 5" APART. A COMMON POINT OF CONNECTION TO THE RAIL MAY BE USED.
BOND WIRES - HEAVY GAUGE RAILHEAD TYPE PREFERRED, WELDED OR SWAGED SECURELY TO RAILHEAD.
TRACK LEADS - AWG #6 INSULATED, TWISTED 3 TURNS/FT, TO BE AS SHORT AS POSSIBLE. SEE INSTRUCTION PAMPHLET U-5865 FOR ADDITIONAL DETAILS.
NOTE: NO OTHER TYPE OF TRACK CIRCUIT CAN BE SUPERIMPOSED ON THE HIGH FREQUENCY CIRCUIT.



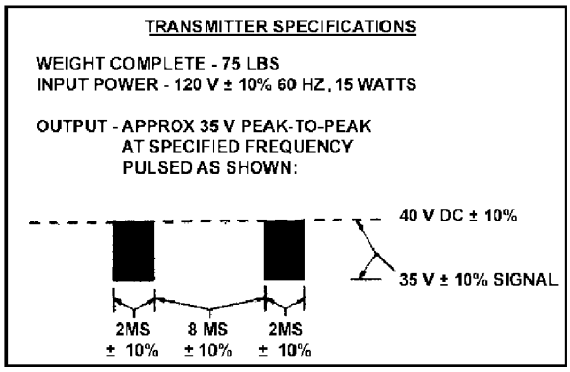
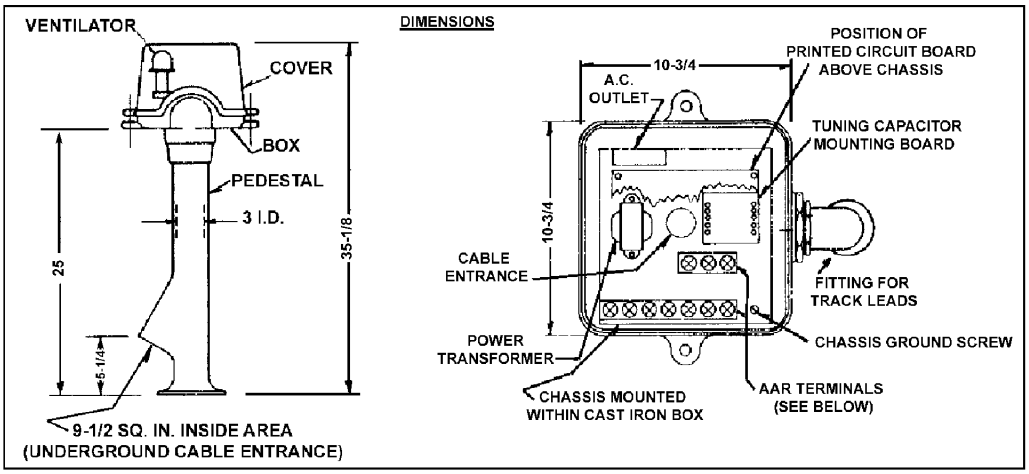

TRANSMITTER SPECIFICATIONS
WEIGHT COMPLETE - 75 LBS
INPUT POWER - 120 V ± 10% 60 HZ, 15 WATTS
OUTPUT - APPROX 35 V PEAK-TO-PEAK AT SPECIFIED FREQUENCY PULSED AS SHOWN:
40 V DC ± 10%
35 V ± 10% SIGNAL
2MS ± 10%
8 MS ± 10%
2MS ± 10%

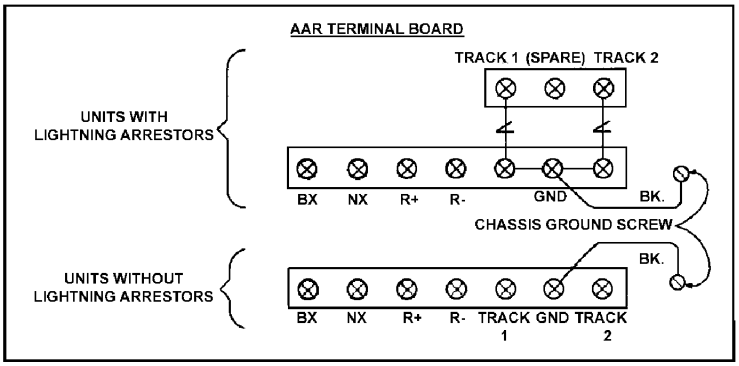
FIGURE A-3B. TRANSMITTER CIRCUIT DIAGRAM AND PARTS REFERENCE



ORDERING REFERENCES

PART NUMBER (DWG F451147 SH. 01)	FREQUENCY KHZ
N451147-0101	46.5
N451147-0105	57
N451147-0109	71.5
N451147-0113	89

ALL PART NUMBERS
DISPLAYED INCLUDE
LIGHTNING ARRESTERS



RECEIVER SPECIFICATIONS

WEIGHT COMPLETE - 75 LBS.
INPUT POWER - 120 V ± 10% 60 HZ (3 WATTS)
OUTPUT - SEE RELAY TIMING CHART BELOW

RECOMMENDED RELAYS

1. PN150B, 6FB, 400 Ω, N322500-901, D66000-3, BASE-N334266, D66002-1
2. PN250B, 6FB-6F-3B, 250 Ω, N322554-901, D66334-14, BASE-N373979, D66339-1
3. PN250B, 8FB-4F-2B, 250 Ω, N322554-902, D66334-14, BASE-N434650, D66339-1
4. DN-11, 6FB, 500 Ω, N159871, C9077-15, STD. PLUG COUPLER-N221084, C16749-4

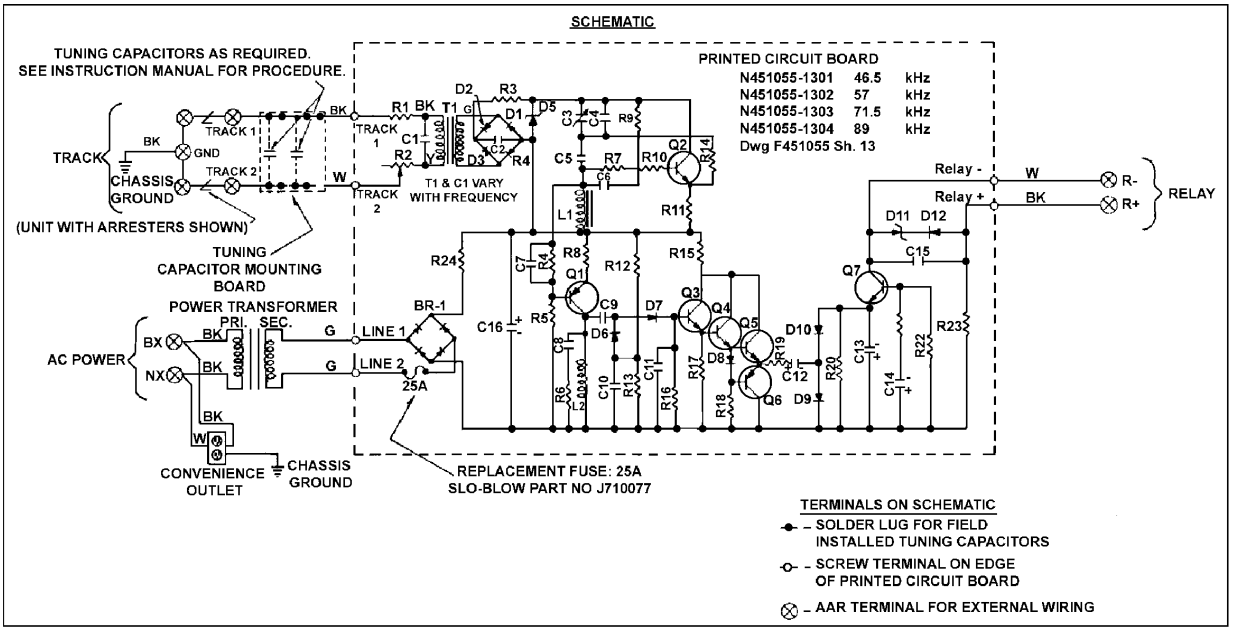
RELAY TIMING

RELAY	COIL RESIST	RCVR OUTPUT TO RELAY COIL VOLTS	DROP AWAY TIME MILLISECONDS	PICK-UP TIME MILLISECONDS
PN-150B, N322500-901	400 Ω	6.1	50	550
PN250B, N322554-901 OR 902	250 Ω	6.05	55	560
PN150B, N3225900-901	400 Ω ▭	6.1	60	550
PN-250B, N322554-901 OR 902	250 Ω ▭	6.05	70	560

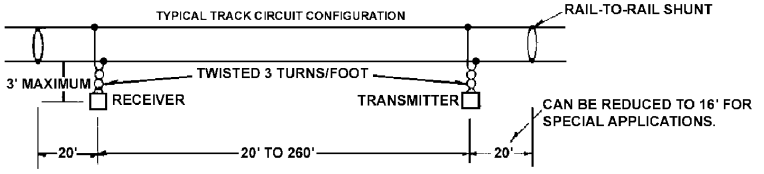
▭- COIL SHUNTED BY TRANSIENT VOLTAGE SUPPRESSOR (J723937)

HIGH FREQUENCY TRACK CIRCUIT RECEIVER

FIGURE A-4A. RECEIVER CIRCUIT DIAGRAM AND PARTS REFERENCE



The US&S High Frequency Track Circuit is intended for such uses as classification yards, car dumpers, etc., where a short track circuit with good shunting characteristics with dirty or greasy rail is required. Rail-to-rail shunts define track circuit limits without insulated joints.



NOTE: No other type of track circuit can be superimposed on the high frequency circuit.

LEGEND	TYPE/VALUE
C2	.047 MF
C3	37-250 PF
C4	820 PF
C5, 7	10000 PF
C6	1500 PF
C8	8200 PF
C9, 11	5100 PF
C10, 15	.1 MF
C12, 13, 14	100 MF
C16	250 MF
D1, 2, 3, 4, 6, 7	1N456
D5	1N959B
D8, 8, 10, 12	1N4003
D11	1N752A
L1	680 MH.
L2	68 MH.
Q1, 6	2N4037
Q2	2N3643
Q3, 4, 5	2N2270
Q7	2N3440
R1, 10, 14	100
R2	1500
R3	510
R4	22K
R5	.1 MEG
R6	2.7
R7, 9	33K
R8	220
R11	4.7K
R12	68K
R13, 17	10K
R15	33
R16	47K
R18	1K
R19	10
R20, 22	2.2K
R21	470
R23	120
R24	10, 2W

MAXIMUM DISTANCE, RECEIVER TO RELAY

Relay Resistance	Wire Size			
	#6	#9	#12	#14
250 OHM	5250'	2625'	1300'	825'
400 OHM	7650'	3825'	1900'	1200'

HIGH FREQUENCY TRACK CIRCUIT RECEIVER

CIRCUIT SYMBOL

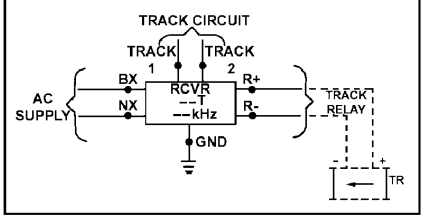


FIGURE A-4B. RECEIVER CIRCUIT DIAGRAM AND PARTS REFERENCE

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